

## University of Dundee

### "Reading between the lines"

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DOI:

[10.5281/zenodo.4561359](https://doi.org/10.5281/zenodo.4561359)

Publication date:

2021

Licence:

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Document Version

Publisher's PDF, also known as Version of record

[Link to publication in Discovery Research Portal](#)

*Citation for published version (APA):*

Sicilia-Aguilar, A., Campbell-White, J., Bouvier, J., Roccatagliata, V., Matsumura, S., Manara, C. F., de Boer, J., & Kospal, A. (2021). "Reading between the lines": *Magnetospheric accretion, winds, and the inner disk*. Poster session presented at Cambridge Workshops of Cool Stars, Stellar Systems and the Sun 20.5 , United States. <https://doi.org/10.5281/zenodo.4561359>

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## Magnetospheric accretion, winds, and the inner disk

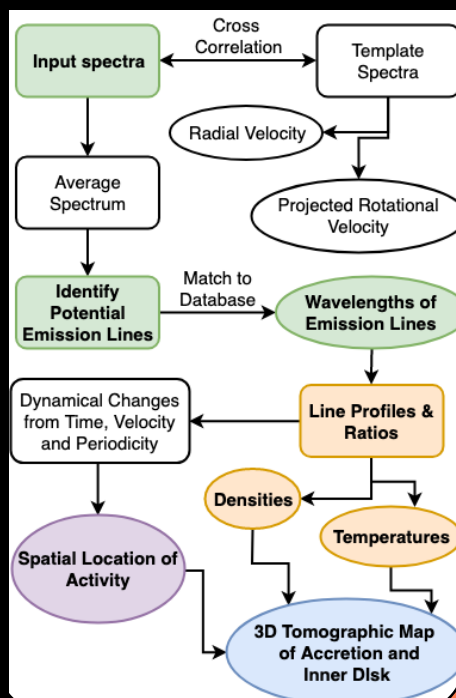
Aurora Sicilia-Aguilar<sup>1</sup>, Justyn Campbell-White<sup>1</sup>, Jerome Bouvier<sup>2</sup>, Veronica Roccatagliata<sup>3</sup>, Soko Matsumura<sup>1</sup>, Min Fang<sup>4</sup>, Carlo Manara<sup>5</sup>, Jos de Boer<sup>6</sup>, Ágnes Kóspál<sup>7</sup>

1: University of Dundee 2: IPAG Grenoble 3: University of Pisa 4: Purple Mountain Observatory 5: ESO 6: Leiden Observatory 7: Konkoly Observatory

### STAR-MELT: What can you learn "reading between the lines" ?

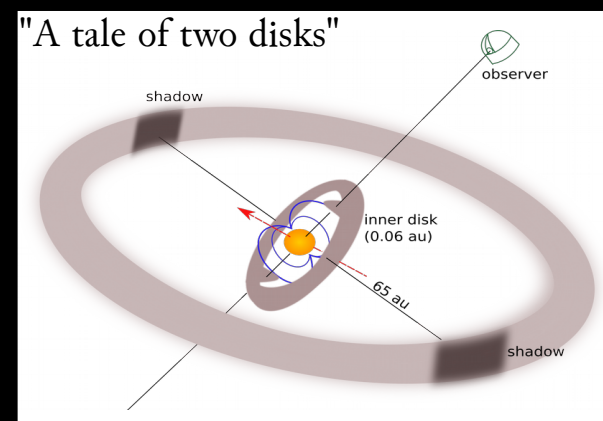
Time- and velocity-resolved data using emission (and absorption) lines in young stars reveal their winds, accretion-related structures, spots, and innermost disk at few-stellar-radii to sub-au scales. Optical spectra have a large number of metallic species with various excitation potentials, useful to trace the temperature, density, and velocity of hot and tiny structures. Time-resolved data covering several rotational and disk orbital periods reveal a very detailed view of the structure of accretion columns and spots and information on the properties and location of stellar/disk winds in young stars. STAR-MELT [Campbell-White+2021 to be subm] is optimized for line extraction and fitting, and will be made public as a Python package soon.

STAR-MELT is funded by STFC grant ST/S000399/1

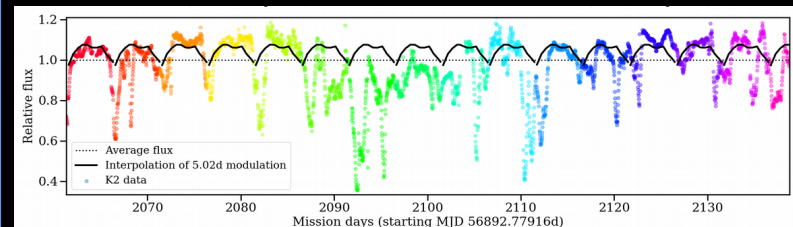


### J1604:

Disk evolution at 0.06-4 au

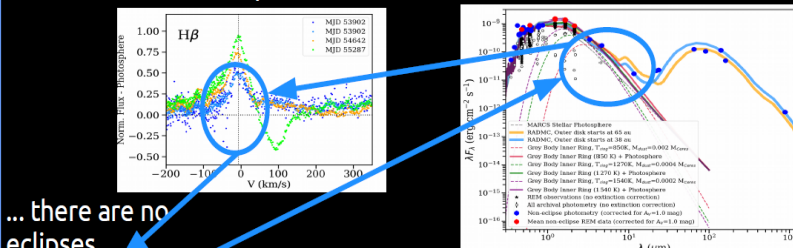


Accretion fills and drains the innermost highly inclined disk every 10-20 days, changing the shape of the dips.

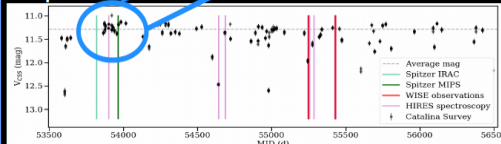


Moreover:

When accretion drops...



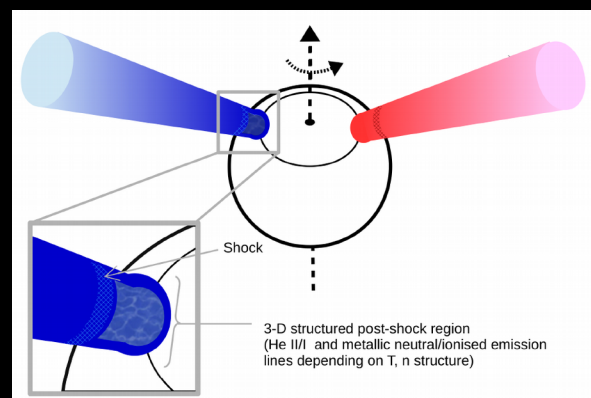
... there are no eclipses...



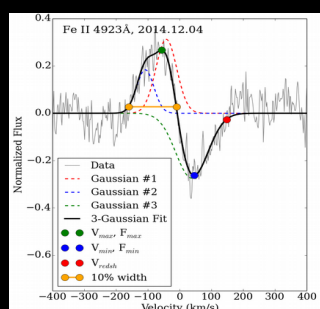
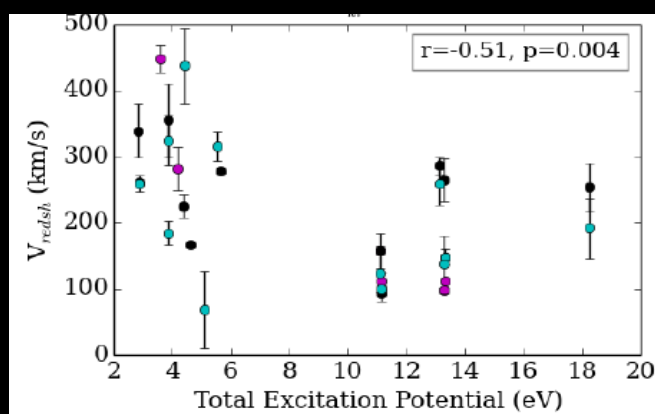
... and no inner disk!  
Major changes in the disk occur every ~2-4yrs.

The inner disk appears and disappears on few-year timescales, betraying "something" at few au in the disk that affects mass transport [SA+2020a]

### Outbursting stars: EX Lupi and ASASSN13db

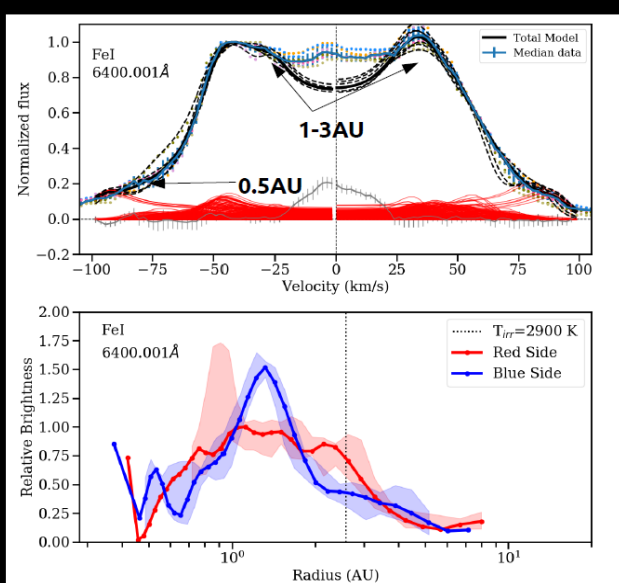


**EX Lupi:** High- vs low-energy lines trace very stable accretion columns with a temperature and density stratification (and even trailing/distribution over the stellar surface) [SA+2015]

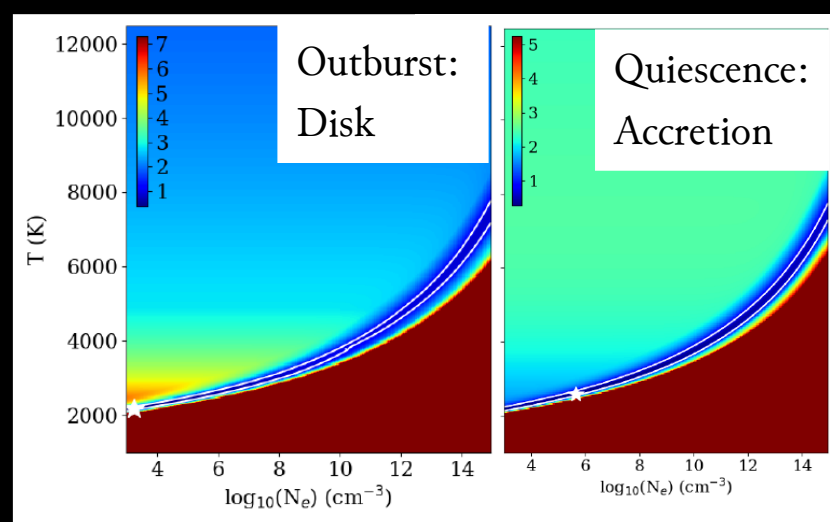


**13db:** Energetics of lines reveals hot spot hovering over surface of M5 star [SA+2017]

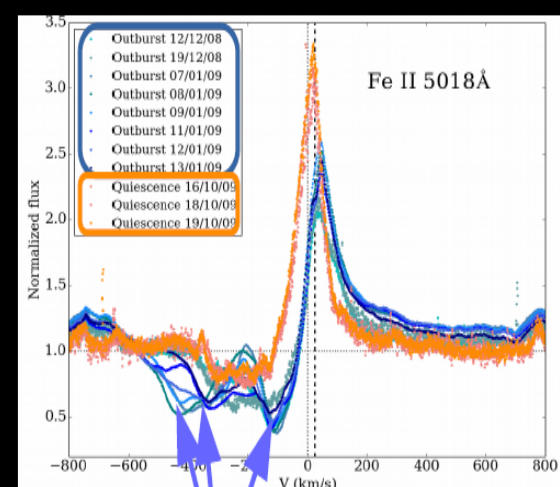
### ZCMa NW: Accretion, inner disk, and non-axisymmetric winds in an intermediate-mass star



Peering through the inner (0.5-3 au) disk at various heights via weak/strong Fe I lines: midplane vs surface asymmetries.



Lines with the same profiles can be used to track temperatures and densities in outburst and quiescence



Multiple variable, non-axisymmetric winds from star and disk [Sicilia-Aguilar et al. 2020b]

### References

Campbell-White et al. subm soon!  
See JCW poster & haiku

SA et al. 2015, A&A 580, 82  
SA et al. 2017, A&A 607, 127  
SA et al. 2020a, A&A 633, 37  
SA et al. 2020b, A&A 643, 29

**Your stars are no longer young? You have lines but no stars?**  
No problem! If lines are there, STAR-MELT can find them and read between them! Please contact ASA & JCW for details.